(12) UK Patent Application (19) GB (11) 2 238 267 (13) A

(43) Date of A publication 29.05.1991

(21) Application No 8924578.1

(22) Date of filing 01.11.1989

(71) Applicant
STC plc

(Incorporated in the United Kingdom)

1B Portland Place, London, W1N 3AA, United Kingdom

(72) Inventors
Aubrey Michael Crick
William Alexander Reeves
Norman John Cann

(74) Agent and/or Address for Service
J P W Ryan
STC Patents, West Road, Harlow, Essex, CM20 2SH, United Kingdom

(51) INT CL[5]
B23K 1/19

(52) UK CL (Edition K)
B3R RPM R61470 R61473 R71471 R71472 R71489 R74017

(56) Documents cited
None

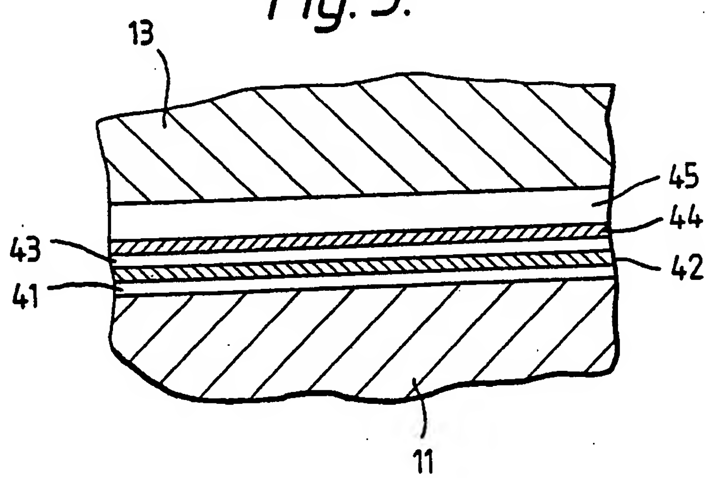
(58) Field of search
UK CL (Edition J) B3R
INT CL[4] B23K

(54) **Brazing process**

(57) In a process for brazing a silicon body (11) to a metal body (13), the silicon body is provided with an adherent oxide surface film (41). The oxide film is coated with a metal layer structure which provides a brazable surface. Attack of the silicon surface by braze alloy is prevented by the oxide film. The metal layer structure comprises titanium (42), molybdenum (43) and nickel (44). The braze (45) is a silver/copper alloy.

The process may be used in the construction of e.g. a pressure sensor assembly.

Fig. 3.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 238 267 A

Fig. 1.

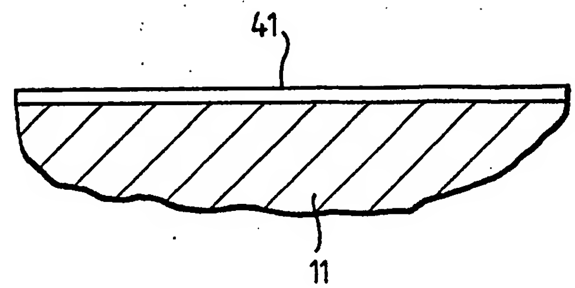


Fig. 2.

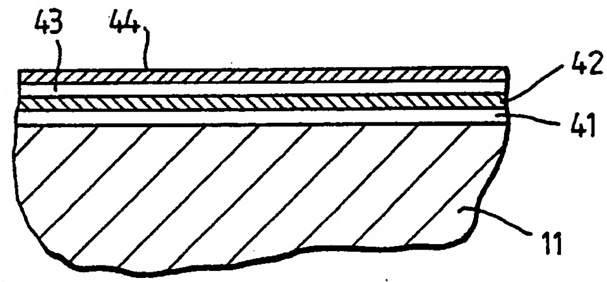
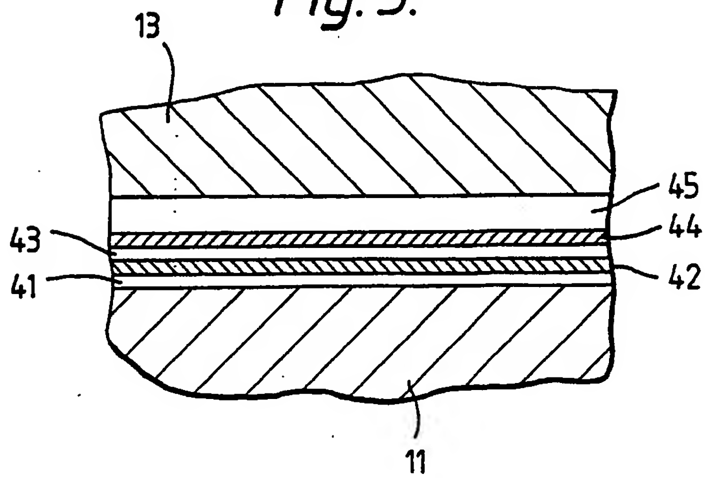


Fig. 3.



BRAZING PROCESS

This invention relates to brazing processes and in particular to a process for providing a brazed silicon to metal seal. The invention also relates to transducer structures fabricated via the brazing process.

Transducers formed from single crystal silicon are finding increasing use in remote sensing applications. Such transducers generally consist of an integral or multipart structure formed by relative etching from single crystal silicon and having one or more flexible piezo-sensitive elements whose displacement provides a measure of the physical parameter, e.g. temperature or pressure, to be determined. Transducers of this type are described for example in our co-pending application No. 88 23234.3 and No. 88 03355.

A particular application for single crystal silicon transducers is in the oil and gas exploration industry where there is a requirement for down-well monitoring of temperature and pressure. The use of silicon transducers in such applications has however been restricted by the necessity to mount the transducer on a metal support or leader to provide a structure that will withstand the very high pressures and temperatures pertaining in an oil or gas well. Specifically, difficulties have been experienced in providing a gas

tight seal between the silicon structure and the metal support. Typically the support comprises molybdenum or a nickel ion cobalt alloy, these materials being thermally matched to silicon. Attempts to provide a gas tight seal by brazing the silicon transducer to the housing have not been successful as it has been found that the braze alloys normally employed to effect gas tight seals react vigorously with silicon to form low melting point intermetallic materials. This results in failure of the joint.

The object of the invention is to minimise or to overcome this disadvantage.

According to the invention there is provided a method of brazing a silicon body to a metal body, the method including providing a surface insulating refractory film on the silicon body whereby to prevent contact of the silicon surface with the braze material.

According to the invention there is further provided a method of forming a gas-tight brazed seal between a silicon body and a metal body, the method including oxidising the surface of the silicon body to form an adherent oxide film, applying to said oxide film a film of a brazable metal, providing a braze alloy on the brazable metal film, contacting the brazable metal with said metal body, and heating the assembly to fuse the braze alloy and effect the brazed seal, the oxide film providing a barrier between the braze alloy and the silicon surface.

According to the invention there is further provided a method of forming a gas-tight brazed seal between a silicon transducer element and a metal support, the method including providing an oxide film on a surface of the silicon element, applying a metal

bonding layer to the oxide film, applying a layer of a brazable metal to the bonding layer, contacting the brazable metal layer with said metal support, heating the assembly, and providing a braze alloy at the interface of the support and the brazable layer whereby to provide a brazed joint therebetween, the oxide film providing a barrier between the braze alloy and the silicon surface.

The oxide layer and the bonding layer provide a physical barrier between the silicon surface and the brazing alloy. This prevents the formation of low melting point intermetallic compounds and thus provides a gas-tight seal that retains its integrity even at elevated temperatures and pressures. The oxide layer further provides a firm bond between the metal layer and the silicon surface.

An embodiment of the invention will now be described with reference to the accompanying drawings in which:-

Figs. 1 to 3 illustrate successive stages in the provision of a brazed silicon to metal seal.

Referring to Figs. 1 to 3, these Figures illustrate the brazing process. An insulating refractory, e.g. oxide, film 41 is formed on the surface of a silicon body 11 to provide a firmly adherent barrier layer whereby a subsequently applied braze alloy is separated from the silicon surface. The oxide film 41 may be formed by heating the silicon in air and is typically about 1 micron in thickness. Next an adherent bonding layer 42 (Fig. 5) is applied to the oxide film 41 to provide a base for further metal/alloy layers. Typically this bonding layer 42 comprises a 0.3 micron thick layer of titanium applied by sputtering.

The bonding layer 42 is coated with a layer 43 of a brazable metal such as molybdenum. This layer 43 may be about 2 microns in thickness and may be applied by sputtering.

Advantageously a nickel layer 44 is applied to the surface of the brazable layer 43 to improve the brazing qualities of the structure. Typically the nickel layer is applied by sputtering and is 1 micron in thickness.

A layer 45 (Fig. 3) of braze alloy is applied to the structure which is then mounted in abutment with a metal body 13 to which the silicon body 11 is to be brazed. Typically this metal body 13 is formed from a material having a thermal expansion coefficient similar to that of silica. We have employed molybdenum and nickel/iron/cobalt alloys such as KOVAR (Registered Trade Mark) for this purpose.

The assembly is next heated to fuse the braze alloy and to effect sealing of the joint between the tube 11 and the header 13. Advantageously the braze alloy comprises a silver/copper eutectic mixture.

During the brazing process the oxide layer 41 and the bonding layer 42 provide a physical barrier between the alloy and the silicon surface thus preventing attack of the silicon. We have found that the oxide and metal layer structure is strongly adherent to the silicon surface thus assuming that a reliable brazed seal is provided by the process described above.

It will be appreciated that the relative thicknesses of the various layers depicted in Figs. 1 to 3 are not to scale.

The brazing process described above is particularly appropriate for mounting a silicon transducer in a metallic housing to form e.g. a pressure sensor. It will however be appreciated that the process is not limited to this particular application but is of general use in the provision of a brazed joint between a silicon body and a metal body.

CLAIMS

1. A method of brazing a silicon body to a metal body, the method including providing a surface insulating refractory film on the silicon body whereby to prevent direct contact of the silicon surface with the braze material.

2. A method of forming a gas-tight brazed seal between a silicon body and a metal body, the method including oxidising the surface of the silicon body to form an adherent oxide film, applying to said oxide film a film of a brazable metal, providing a braze alloy on the brazable metal film, contacting the brazable metal with said metal body, and heating the assembly to fuse the braze alloy and effect the brazed seal, the oxide film providing a barrier between the braze alloy and the silicon surface.

3. A method of forming a gas-tight brazed seal between a silicon transducer element and a metal support, the method including providing an oxide film on a surface of the silicon element, applying a metal bonding layer to the oxide film, applying a layer of a brazable metal to the bonding layer, contacting the brazable metal layer with said metal support, heating the assembly, and providing a braze alloy at the interface of the support and the brazable layer whereby to provide a brazed joint therebetween, the oxide film providing a barrier between the braze alloy and the silicon surface.

4. A method as claimed in claim 2 or 3, wherein said brazable metal comprises molybdenum.

5. A method as claimed in claim 4, wherein a layer of titanium is disposed between the oxide film and the molybdenum layer.

6. A method as claimed in claim 4 or 5, wherein a layer of nickel is applied to the surface of the molybdenum layer.

7. A method as claimed in any one of the preceding

claims wherein the braze alloy comprises a silver/copper eutectic mixtures.

8. A method of brazing a silicon body to a metal body substantially as detailed herein with reference to Figs. 1 to 3 of the accompanying drawings.

9. A transducer assembly fabricated by a method as claimed in any one of claims 1 to 8.

Published 1991 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.